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Dated 7 February 2009

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24 OCT 2003
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P01/7700 0.00-0324830.9

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The Patent Office

Cardiff Road
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1. Your reference — PAZ - VPD2 — 24 OCT 2003

2. Patent application number
(The Patent Office will fill in this part) — ~~02 JUL 2003~~ — 0324830.9

3. Full name, address and postcode of the or of each applicant *(underline all surnames)*

Dr Adrian Paz
13 Eliezer Friedman street, Appt. 52,
Petah Tikva 49444,
Israel

08665861001
Patents ADP number *(if you know it)*

If the applicant is a corporate body, give the country/state of its incorporation

4. Title of the invention

Virtual ports devices

5. Name of your agent *(if you have one)*

"Address for service" in the United Kingdom to which all correspondence should be sent *(including the postcode)*

Marc Zuta
Marc Zuta
72 New Bond Street
London W1S 1RR

Patents ADP number *(if you know it)* 08403818004

6. If you are declaring priority from one or more earlier patent applications, give the country and the date of filing of the or of each of these earlier applications and *(if you know it)* the or each application number

Country	Priority application number *(if you know it)*	Date of filing *(day / month / year)*
U.K.	GB 0315479.6	02-07-03

7. If this application is divided or otherwise derived from an earlier UK application, give the number and the filing date of the earlier application

Number of earlier application	Date of filing *(day / month / year)*
~~GB 0315479.6~~	~~02-07-03~~ see oic dated 21-11-03

8. Is a statement of inventorship and of right to grant of a patent required in support of this request? *(Answer 'Yes' if:*

a) any applicant named in part 3 is not an inventor, or
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Description	24 ✓
Claim(s)	4 ✓
Abstract	1 ✓
Drawing(s)	19 + 19 ✓

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Priority documents	---
Translations of priority documents	---
Statement of inventorship and right to grant of a patent *(Patents Form 7/77)*	---
Request for preliminary examination and search *(Patents Form 9/77)*	---
Request for substantive examination *(Patents Form 10/77)*	---
Any other documents *(please specify)*	--- S1/77 ✓

11. I/We request the grant of a patent on the basis of this application.

Signature

Date 21.10.03

12. Name and daytime telephone number of person to contact in the United Kingdom Marc Zuta Tel. 020 7514 5884, 078 1764 4554

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Virtual Ports Devices

Field of the Invention

This invention relates to devices auxiliary to surgery, and more particularly to such devices for anchoring and lifting cavity walls or internal organs of a patient. The present application claims priority from application GB 0315479.6 filed on 02 July 2003 in the United Kingdom.

Background of the Invention

This invention relates to anchoring devices for retractors and/or for lifting the cavity walls, being attached to the internal surface of a cavity or to various organs within a cavity, during minimally invasive surgery. More specifically, the invention relates to minimally invasive or preferentially non-invasive anchoring system and devices for attachment to the internal walls of the cavity, or on the organs within a cavity in which the intervention is performed, at another location than the orifice through which they were originally introduced.

Preferably, the device can be moved and re-attached, one or more times, non-invasively or minimally invasively, to other locations in the interior of the cavity. Such devices are denoted throughout the patent application as virtual ports. The purpose of such virtual port devices is to supply an anchoring device for retracting various tissue and organs by self-retained retractor means, or to supply an anchoring device for instruments which are attached to these virtual port devices.

This anchoring permits instruments within the cavity to be moved in any possible direction and at any angle. Such devices may comprise attachment of the device on the underside of the cavity, or on internal organs and tissues, by magnetic attachment means, suction attachment, adhesive attachment, mechanical attachment by small barbs, or clips, other minimally invasive means such as wires introduced through the entire thickness of the cavity wall and attached to the anchoring device on the internal side of the cavity, any combination of these modalities, or other non-invasive or minimally invasive anchoring means that might be envisioned for those accustomed to the art.

Additionally, in case the anchoring device is held in place by a device situated on the on exterior surface of a cavity such as the abdomen, these devices may serve also for lifting the cavity wall and permit performance of atmospheric pressure laparoscopy. The devices on the outer surface of the cavity can be attached to a frame or to rods fixed to the operating table, to the operating room floor or ceiling and serve for lifting the cavity wall, permitting to perform the intervention without the necessity to insufflate the cavity with gas.

Gas insufflation has its potential drawbacks such as generation of positive pressure, which in case of abdominal laparoscopy can be detrimental in obese patients, patients with chronic respiratory and/or cardiac diseases. Additionally gas insufflation, necessitates an insufflator device, can result in rapid loss of the working cavity when there is a gas leak, or when the gas exhaust resulting in inadequate view of the surgical site.

Laparoscopic interventions represent a significant advance in various fields of surgery permitting the performance of the majority of interventions through a number of small incisions reducing postoperative pain and enhancing the postoperative recovery. However there are still a significant number of drawbacks to this technique. The fixed position of the access openings in the wall of the cavity - access ports- significantly limits the approach to some surgical locations making some interventions very long and technically demanding. Creation of additional ports may negate the minimal invasive nature of the procedure. Some ports are used mainly for introducing retracting instruments in order to facilitate dissection.

The fixed position of the ports may hinder retraction in various directions, and the limited potential access sites (as for example anterior and lateral walls, but not posterior, proximal and distal walls of the abdomen for abdominal laparoscopy) may make retraction in some directions impossible.

Magnetic attraction has been used in medicine to remotely attach devices to tissue, or to remotely manipulate tissue. So, in patent US6358196, issued to RAYMAN REIZA magnetic substances are introduced into the intestine by ingestion and the intestines are remotely manipulated by an electromagnet during laparoscopic surgery. However this device does not permit retraction of an abdominal organ other than intestine and does not permit precise retraction of a particular segment of intestine.

In patents US2003009080, US6494211, a suction device is used to attach a retractor to various organs such as the heart in order to retract it in a specific direction. However these devices are introduced trough orifices in the body wall and they are not virtual ports since they can not permit non invasive anchoring of the retractor to the undersurface of the cavity wall, or within the cavity in another location than the access port.

In patents WO03013366, US6206827 a retractor device is attached to the organ to be retracted by some adhesive. However, the retractors are introduced through an orifice and does not represent a virtual port since they can not permit non invasive anchoring of the retractor to the undersurface of the cavity wall, or within the cavity in another location than the access port.

In patent US6206827, a retractor is directly attached to tissue by penetrating it with mechanical sharp means such as barbs or springs and traction on this means cause tissue retraction. However, the retractors are introduced through an orifice and does not represent a virtual port since they can not permit non invasive anchoring of the retractor to the undersurface of the cavity wall, or within the cavity in another location than the access port.

In patents EP1287786, US5690607 abdominal wall retractors that may be used for gasless laparoscopy are described. However, these devices can be used only for lifting the body wall and cannot be used, neither for anchoring endoscopic graspers, necessary for retracting intra-abdominal tissues and organs, nor for anchoring instruments at various position on the undersurface of the abdominal cavity. Additionally, when using rods for retraction, a few mm orifices are performed in the body wall.

There is a need for an anchoring device that is non invasively and removably attached to the undersurface of a cavity, or to various tissues within a cavity, or to tissues within a cavity, during minimally invasive surgery acting as an anchoring device for a retractor.

There is a need for an anchoring device, to which various retractors are attached, that is non invasively and removably attached to the interior surface of a cavity, or to various tissues within a cavity, and that can be moved to any other position easily.

There is a need for such an anchoring device that is non-invasively and removably attached to the interior surface of a cavity by magnetic attraction using a magnet or electromagnet on the exterior surface of the cavity.

There is a need for an anchoring device that is non-invasively and removably attached to the interior surface of a cavity, or to various tissues within a cavity, by using suction.

There is a need for an anchoring device that is non-invasively and removably attached to the interior surface of a cavity, or to various tissues within a cavity, by using suction in which the suction is applied continuously or in which the suction tube is detachable.

There is a need for an anchoring device that is non-invasive and removably attached to the interior surface of a cavity, or to various tissues within a cavity, by using a pressure sensitive gel or other reversible adhesive means.

There is a need for an anchoring device that is minimally invasive and removably attached to the interior surface of a cavity, or to various tissues within a cavity, using mechanical means such as barbs, or fixation wires.

There is a need for an anchoring device that is non-invasively or minimally invasively and removably attached to the interior surface of a cavity, that can permit lifting the cavity wall for performing gasless laparoscopy

There is a need for an anchoring device that is non-invasively and removably attached to the interior surface of a cavity, or to various tissues within a cavity, using any combination of the above means.

Applicant believes these needs are not answered in prior art, as well as other problems which will become apparent upon reading the present disclosure.

Summary of the Invention

A new surgery device includes means for anchoring and lifting cavity walls or internal organs of a patient.

The device provides a virtual port, that is an instrument that can be non-invasively, or minimally invasively and removably attached to the undersurface of a patient's cavity, or to various tissues within a cavity, and to which various retracting means or instruments are attached.

The device includes means allowing it to be moved from one position to another and reattached to the undersurface of the abdominal wall, or to various tissues within a cavity, without creating any additional openings in the cavity wall.

The device includes means for attaching various retractors, etc.

In a preferred embodiment, the device uses a pair of solid magnets, with an inner and an outer part.

The retractor means may comprise a self retaining clamp or other mechanical attachment means, a vacuum activated attachment means, a adhesive attachment means such as a pressure adhesive gel or a combination thereof.

In another embodiment, the virtual port device comprises an inflatable chamber, which can be filled with a magnetisable gel or emulsion, or by magnetisable particles.

In yet another preferred embodiment, the virtual port device is provided with a suction device that allows attaching the device to the interior surface of the cavity or to various tissues within a cavity.

In another preferred embodiment, the virtual port device comprises a suction cup with an elastic membrane, which is coated on its tissue facing surface with a pressure sensitive adhesive gel that permit better attachment to the cavity wall, or to various tissues within a cavity.

In another preferred embodiment, the virtual port anchoring device is attached to the inner side of the cavity by small barbs that penetrate the tissue when the device is pressed by the introducer against it.

In another preferred embodiment, the virtual port anchoring device is attached to the inner side of the cavity by wires that penetrate and pierce the cavity wall. Preferably, the attachment device is shaped as an umbrella that opens on the undersurface of the cavity and is held in this position by and prevented from flipping back on itself by some reinforcing means.

In another preferred embodiment, the virtual port anchoring device is attached to the inner side of the cavity by a self-retaining clamp.

The embodiments in which the anchoring means are held in place by some device on the outer surface of the cavity, such as by magnetic attraction or by wires piercing the entire thickness of the cavity, can serve also for gasless (atmospheric pressure) endoscopy or laparoscopy.

The anchoring device may serve also for anchoring and as a hinge for instruments, etc.

Further objects, advantages and other features of the present invention will become obvious to those skilled in the art upon reading the disclosure set forth hereinafter.

Brief Description of the Drawings

Fig. 1 virtual anchoring point device with internal magnet

Fig. 2 details the internal magnet

Fig. 3 details a virtual port using a vacuum cup with vacuum tube

Fig. 4 details a virtual port using a vacuum cup with detachable canula

Fig. 5 details a virtual port using a vacuum cup with canula and vacuum reservoir

Fig. 6 details a vacuum/magnetic cup with canula

Fig. 7 details a virtual port including a wire with a reversed umbrella-shaped device before being attached into place

Fig. 8 details a virtual port use of a wire with a reversed umbrella-shaped device attached into place

Fig. 9 details an inner body with fluid magnetic filling

Fig. 10 details a virtual port self retaining clips

Fig. 11 details the structure of a virtual port self retaining clips

Fig. 12 details another embodiment of a virtual port self retaining clips

Fig. 13 details a virtual port self retaining clips with a vacuum cup/grasping means

Fig. 14 details a net for holding internal organs or pushing them aside

Fig. 15 details means for holding an internal organ by attaching it to a virtual port

Fig. 16 details a balloon with affixed virtual port devices

Fig. 17 details vacuum cup with a two-state valve in its Closed state

Fig. 18 details vacuum cup with a two-state valve in its Open state

Fig. 19 illustrates a plurality of vacuum cups connected to a common vacuum pump

Fig. 20 details vacuum cup with a two-state, toggle-switch activated valve in the Vacuum Activate state

Fig. 21 details vacuum cup with a two-state valve in the Vacuum Preserve state

Fig. 22 details vacuum cup with a three-state, switch-activated valve in the Vacuum Activate state

Fig. 23 details vacuum cup with a three-state, switch activated valve in the Vacuum Preserve state

Fig. 24 details vacuum cup with a three-state, switch activated valve in the Vacuum Release state

Fig. 25 illustrates an electronically-controlled vacuum pump 7

Fig. 26 illustrates a cup-moving means with partial vacuum reduction

Fig. 27 illustrates another cup-moving means with partial vacuum reduction

Detailed Description of the Preferred Embodiments

A preferred embodiment of the present invention will now be described by way of example and with reference to the accompanying drawings.

The device of the present invention provides a virtual port, that is an instrument that can be non-invasively and removably attached to the undersurface of a patient's cavity, or to various tissues within a cavity, and to which various retracting means are attached.

The device is initially introduced through an opening in the cavity wall and then attached to some location on the undersurface of the cavity wall, or to various tissues within a cavity, by some non-invasive attachment means.

Fig. 1 illustrates a virtual anchoring point device with internal magnet, to attach to an abdominal wall 11 of the abdominal cavity 12 , inside the human body. There is an outer magnet or electromagnet 31, connected to holding/moving means 32, such as an articulate arm or robot arm or manual holding handle.
The outer magnet can be secured to the ceiling or a wall or another fixed spot.

The system also includes an inner magnet 21, or body having ferromagnetic properties. A terminal loop or protuberance 22, at one or both ends of the elongated body of magnet 21, is used to pull it in or out of the human body. The device also includes a ratchet mechanism 23, which holds the string 24 after it is pulled in the direction shown with arrow 41 , then the clips 25 attached to the other side of wire 24, pulls the internal organ 13 to which it is attached.

A lever 26 when activated, releases the ratchet mechanism 23, so that the tension in wire 24 is released, to stop pulling the internal organ 13

Dual use of device:

1. to hold open the internal body cavity 12, such as the abdominal cavity by applying a force outwards, generally in the direction of arrow 42. The body cavity can thus be kept open, filled with gas at about atmospheric pressure - no higher pressure is required.

2. to act as virtual anchor point to pull internal organs 13 towards it. one or more organs can be pulled towards the anchor point

The inner magnet 21 can be moved to another location by moving the outer magnet 31 laterally, as indicated with the arrow 43.

The device can be moved from one position to another and reattached to the undersurface of the abdominal wall, or to various tissues within a cavity, without creating any additional openings in the cavity wall.

In a preferred embodiment, the device includes a solid magnet that can be introduced through an opening in a cavity wall such as the abdominal wall. The device shape is spherical or elongated and enough magnetisable substance is incorporated to permit effective attraction by a magnet on the exterior surface of the cavity. The device is smoothed, or coated with a smooth coating permitting it to slide easily on the undersurface of the cavity.

To the virtual port device may be attached, through a string, a tissue attachment means. This system will cause retraction by pulling toward the anchoring means. Alternatively, instead of a string, a rod may be attached to the anchoring means, serving to push away the tissue from the anchoring device.

The device is preferably polished, processed to achieve a smooth outer surface, or coated with a smooth coating permitting it to slide easily on the undersurface of the cavity, or on various tissues within a cavity. To the virtual port device is attached, through a string, a tissue grasping means.

The attachment means may represent a self retaining clamp, grasper, or other mechanical attachment means, a vacuum activated attachment means, an adhesive attachment means such as a pressure adhesive gel or a combination thereof. This system will cause retraction by pulling toward the anchoring means.

Alternatively, instead of a string, a rod may be attached to the anchoring means serving to push away the tissue from the anchoring device. Also, a combination of pulling and pushing retractor means may be used.

The grasping means of the tissue retractor may include a self-retaining clamp or other mechanical attachment means, a vacuum activated attachment means, a adhesive attachment means such as a pressure adhesive gel or a combination thereof.

Additionally, the grasping means may be directly to the tissue to be retracted, or to a net, to an elastic sheet, a balloon device, or any combination thereof of such devices, which serve for tissue or organ retraction.

The string that connects the attachment means to the device may be an elastic string, or an adjustable length string, whose length can be adjusted by pulling it through a self locking ratchet mechanism, with a means for manual or remote release of the string tension, or using other mechanisms such as springs, that may be envisioned by those accustomed to the art. Also, strings of various lengths and various tensile strengths and elasticity may be removably attached to the virtual port device using an interlocking or other simple attachment means.

The magnet on the undersurface of the cavity is maintained attached to the abdominal wall by using a magnet or electromagnet on the exterior surface of the cavity. Using a strong enough magnetic field, enough attraction force can be applied to the undersurface magnet, which is at a distance of a few cm or more from the upper surface magnet, and permitting it to hold weight of a few hundred grams, as necessary for tissue and organ retraction. The undersurface magnet, included in the virtual port device, may be advanced to a new position by moving the magnet on the exterior surface of the cavity. When large electromagnets are needed these may be held above the patient by an articulated arm that may be manipulated manually or by specific engines to the desired position.

Fig. 2 details the internal magnet 21, having an elongated shape, preferably cylindrical with rounded ends 211, 212 for easy insertion into the body and extraction therefrom.

In another embodiment, the virtual port device comprises an inflatable chamber, which can be filled with a magnetisable gel or emulsion, or by magnetisable particles. This device can be introduced in a deflated situation through a slender port and inflated by a liquid or semi-liquid substance to a larger volume permitting better attraction by the magnetic field. The inflatable chamber can be connected to an inflating tube continuously or it can be detachably connected to such a tube in which case, one or more one-way valve are provided to prevent spillage.

Such valve means may be provided with a flexible and broad connection means that permit reattachment of the tube at various angles.

The device may be spherical, in which case a single connection means situated on the side opposite to the attachment side to the cavity wall.

The device may be spherical in which case a single connection means situated on the side opposite to the attachment side to the cavity wall. Alternatively, the device may be elongated, in which case more than one connections means and one-way valves may be necessary to be able to reattach the tube to the device from various angles and positions.

Fig. 9 details an inner body 58 which can be filled with a fluid magnetic filling through a tube 582 and valve 581. It is then attracted to an outer magnet or electromagnet 31.

The fluid ferromagnetic material may include, for example: small iron spheres in a gel mixture, or iron powder in oil.

In another preferred embodiment the virtual port device is provided with a suction device that permit attachment of the device to the interior surface of the cavity or to various tissues within a cavity. In this case the exterior wall of the device is shaped preferentially as a cup that is preferentially of reduced elasticity, that permit the device to be introduced through a small orifice but does not allow it to completely collapse when applying vacuum for suction attachment to the tissue. In some embodiments the cup is reinforced with radial ribs to prevent its collapse.

However, the device may be rigid, or elastic. The interior surface is provided with an elastic and impermeable membrane that is sucked in when applying vacuum to the inside of the suction device. The suction cup is provided at its periphery with a sealing rim, shaped as a flange and manufactured from a foamy plastic material or similar material that permits effective sealing and prevent loss of vacuum. Between the membrane and the interior surface of the cup a chamber is created.

Additionally, the elastic membrane may be provided with one or more orifices that permit better suction and attachment. Alternatively, the suction cup may be applied directly to the tissue without an intervening membrane.

In some embodiments an absorbent material is provided inside the suction cup to prevent pooling of liquid, between the suction device and tissue and detachment of the suction device.

The grasping means may be directly to the tissue to be retracted, or to a net, or to an elastic sheet, rod, balloon device, or to any combination thereof, which serve for tissue or organ retraction. The string that connect the attachment means to the device may be an elastic string, or an adjustable length string, whose length can be adjusted by pulling it through a self locking ratchet mechanism, with a means for manual or remote release of the string tension, or using other mechanisms such as springs, that may be envisioned by those accustomed to the art. Also, strings of various lengths and various tensile strengths and elasticity may be removably attached to the virtual port device using an interlocking or other simple attachment means.

Alternatively, the device may be elongated, in which case more than one connections means and one-way valves may be necessary to be able to reattach the tube to the device from various angles and positions. The connector used for attaching the canula may be of a mechanical articulation type for example a bayonet connection, or by using an inflatable balloon at the end of the canula to firmly attach it to a proper cavity on the anchoring device.

Fig. 3 details a virtual port using a vacuum cup with vacuum tube, to attach to the abdominal wall 11. In the abdominal cavity 12 - inside the human body - is inserted a vacuum cup 51, which is flexible/collapsible and connected to vacuum tube 52. The string 24, after being pulled in the direction shown, will pull an internal organ .
A ratchet mechanism 23 holds the tension in the string. A clips 25 attached to the other side of string 24, connects to an internal organ as desired.

Fig. 4 details a virtual port using a vacuum cup with detachable canula, to attach to the abdominal wall 11. The device has a vacuum cup 51, coupled with a vacuum canula 53 through a cup receptacle 512, which receives the canula 53.

In a preferred embodiment the vacuum device is provided with a vacuum accumulator or reservoir, represented by a non collapsible chamber connected to the cup by a one directional valve, that may prevent vacuum lose during the time that the cup is applied to the undersurface of the cavity. The exterior wall of the suction device is connected through a slender tube to a vacuum source.

This connection may be fixed or detachable; in the latter case, one or more one-way valves are provided to prevent vacuum loss when in detached state. Such valve means may be provided with a flexible and broad connection means that permit reattachment of the tube at various angles. The connector used for attaching the canula may be of a mechanical articulation type for example a bayonet connection, or by using an inflatable balloon at the end of the canula to firmly attach it to a proper cavity on the anchoring device.

Fig. 5 details a virtual port using a vacuum cup with canula and vacuum reservoir, including a vacuum cup 51, a vacuum canula 53 with vacuum reservoir 54 with valve to cup 51. If gas enters the cup 51 to lower the vacuum level in cup 51, the reservoir 54 will help maintain the vacuum in the cup 51.
A cup receptacle 512, receives the canula 53 with optionally inflating balloon 532 to hold it there during the vacuum process alternately, the canula can connect to the reservoir 54, to create a higher level of vacuum there- about 0.1 atmosphere, only part of it being created in the vacuum cup 51 (about 0.3 -0.5 atmospheres) so as not to damage tissue.

In another embodiment, the virtual port device is removably attached to the interior surface of the working cavity, or to tissue within the working cavity, by adhesive means such as but not limited to a pressure sensitive gel.

Attachment to the interior surface of the cavity, or to tissue within the working cavity, may be obtained by any combination of the above mentioned means. In a preferred embodiment, the virtual port device comprises a magnet means and suction means. This combination permits using a less bulky magnet mainly for moving the virtual port from one position to another.

During changing the position, the vacuum is reduced and the electromagnet is moved on the upper surface of the cavity to the new location dragging the virtual port device to its new position on the interior surface of the cavity.

Fig. 6 details use of a vacuum/magnetic cup with canula, including a vacuum/magnetic elongated cup 56. The cup height 561 is about 1 cm. A vacuum canula 53 is used to attach to the abdominal cavity 12 - inside the human body.

In another preferred embodiment, the virtual port device comprises a suction cup with an elastic membrane, which is coated on its tissue facing surface with a pressure sensitive adhesive gel that permit better attachment to the cavity wall, or to various tissues within a cavity. The pressure sensitive adhesion gel and elastic membrane may be permeable to gas and/or liquids and an absorbent substance inside the suction cup may be provided too.

The spherical, or elongated device is introduced into a cavity such as the abdominal cavity through a small orifice preferentially of 5 or 10 mm diameter under direct vision. The device is provided with a protuberant means, preferentially situated opposite to the attachment side to the cavity wall, that permit grasping and handling by the introducer. The introducer is represented by a slender instrument provided with a grasping end, that can grasp the device from the protuberant means and bring the virtual port device and position it at the desired location on the interior surface of the working cavity, or onto tissue within the working cavity.

Alternatively, in case of an inflation chamber, or a vacuum device provided with a permanently attached canula, this canula may serve as an introducer means. The same introducer device may serve for changing the position of the device on the inner side of the working cavity wall, or on the tissue within this cavity. In order to do this the introducer means is introduced into the cavity through an existing opening and the virtual port device is grasped under vision by the protuberant means, the attachment means to the cavity wall, or inner tissues such as magnetic, vacuum, adhesive are released completely, or partially, the introducer means will move the virtual port device and the attachment means will be reactivated at this location and the introducer means will be detached from the virtual port device. This maneuver may be repeated as many times as is necessary.

In case the device is provided with a one way valve, or valves and with connection means to these valves, the device may be introduced in the working cavity, and manipulated as above mentioned in the previous paragraph, through the small orifice in the cavity wall by the tube or canula that are affixed to this connection means and positioned to the proper place under vision using this tube or canula means. The connector used for attaching the canula may be of a mechanical articulation type for example a bayonet connection, or by using an inflatable balloon at the end of the canula to firmly attach it to a proper cavity on the anchoring device.

In another preferred embodiment the virtual port anchoring device is attached to the inner side of the cavity by small barbs that penetrate the tissue when the device is pressed by the introducer against it. This entire device, a segment holding the barbs, or only the barbs may be manufactured of biodegradable material. This anchoring device might be shaped as a solid spherical or ellipsoidal device that can be introduced through a small diameter orifice using a detachable introducer, or it can be provided with an inflatable chamber that can be inflated with liquid or gas to a larger volume having a larger attachment surface to the inner surface of the cavity.

In this case, the introducer may be a canula permitting inflation of the chamber through a one-way valve, and being detachable attached to it. The device is released from its position by using traction with the introducer and reattached to another position by a similar maneuver. In case of using a biodegradable device or a part of the device being biodegradable, this segment can be left attached to the original place and the second component can be removed through an orifice in the cavity wall. In case of an inflation canula serving as introducer, this canula is reattached to the one-way valve of the device through a connector, and the device is detached from its location by using traction, and reattached to the new location, or removed from the cavity. The connector used for attaching the canula may be of a mechanical articulation type for example a bayonet connection, or by using an inflatable balloon at the end of the canula to firmly attach it to a proper cavity on the anchoring device.

Alternatively, the device may be attached to the undersurface of the cavity by a clip means, that is advanced over a segment of tissue from the undersurface of the abdominal wall that is grasped or sucked by a specially designed means. Such a device may be designed as an inverse tweezers that has central passage for passing the grasping or suction means and a means for manipulating it and approximating it to the undersurface of the cavity wall.

In another embodiment the anchoring device is attached to the underside of the cavity using a wire shaped as a loop that penetrate the entire cavity wall. This anchoring device might be shaped as a solid spherical or ellipsoidal device that can be introduced through a small diameter orifice using a detachable introducer, or it can be provided with an inflatable chamber that can be inflated with liquid or gas to a larger volume having a larger attachment surface to the inner surface of the cavity.

In this case, the introducer may be a canula permitting inflation of the chamber through a one-way valve, and being detachable attached to it.

Preferably, the attachment device is shaped as an umbrella that opens on the undersurface of the cavity and is held in this position by and prevented from flipping back on itself by some reinforcing means. The increased contact surface of the anchoring device to the inner surface of the cavity may permit better fixation of the anchoring device to the cavity wall. The wire is provided at its end with a loop or other attachment means to the anchoring device, and the anchoring device is provided with a hook means for engaging the loop means of the wire. The wire may be introduced directly through the cavity wall, or through a special needle used to pierce the cavity wall.

The wire is introduced to the proper place though the cavity wall by transillumination guidance or by other imaging means. When moving the anchoring device to another position the device is detached from the wire and this wire, or another wire is introduced to the new position and the anchoring device is attached to the attachment wire using the introducer, by the same maneuver mentioned previously. These mechanical attachment means of the anchoring device are somewhat more invasive than the previously mentioned means by are much less invasive than creating orifices of 5 to 10 mm diameter in the cavity wall necessary for introduction of standard retractors and other working elements.

Gas insufflation has its potential drawbacks such as generation of positive pressure, which in case of abdominal laparoscopy can be detrimental in obese patients, patients with chronic respiratory and/or cardiac diseases. Additionally gas insufflation, necessitates an insufflator device, can result in rapid loss of the working cavity when there is a gas leak, or when the gas exhaust resulting in inadequate view of the surgical site.

The embodiments in which the anchoring means are held in place by some device on the outer surface of the cavity, such as by magnetic attraction or by wires piercing the entire thickness of the cavity, can serve also for gasless (atmospheric pressure) endoscopy or laparoscopy. In this case, an initial port is performed using positive pressure laparoscopy, then the attachment means are attached to the undersurface of the cavity for endoscopic retraction and for retraction of the body wall, thus serving a dual role.

The devices on the outer surface of the cavity can be attached to a frame or to rods fixed to the operating table, to the operating room floor or ceiling and serve for lifting the cavity wall, permitting to perform the intervention without the necessity to insufflate the cavity with gas. Thus, the undesired effects of pressurizing the abdominal cavity during a surgical intervention can be avoided.

Fig. 7 details a virtual port including a wire 571 with a reversed umbrella-shaped device 572 with a hook 573, before being attached into place to abdominal wall 11.

Fig. 8 details a virtual port, use of a wire with a reversed umbrella-shaped device attached into place.

Fig. 10 details a a virtual port self retaining clips, tweezer type, including a vacuum tube 61 for pulling the abdominal wall 11 tissue, a holding tube 62 for pushing the clips means, clips means 63 in place, and outer tube 64 for closing and opening the clips means 63.

Fig. 11 details the structure of a virtual port self retaining clips.

The clips means is made of elastic wire, for example, has a pair of holding tips 631 and a wider base 632, connected through crossed arms 633. By applying force 634 inwards opens the tips 631, such as when the base 632 is in a tube 64 when base 632 is released, then tips 631 close to hold tissue therebetween. A vacuum tube 61 may pass through the base 632.

Fig. 12 details another embodiment of a virtual port self retaining clips, wherein the clips means is made of elastic ribbon example, has a pair of holding tips 641 and a base 642, such as the tips 641 are normally close to each other or in contact with each other by applying force 644 inwards on arms 645 will open the tips 641, to attach to tissue.
There may also be a hole 646 for the vacuum tube 61.

Fig. 13 details a a virtual port self retaining clips with a vacuum cup/grasper means 51 using the aforementioned three tubes structure.

Fig. 14 details a net/mesh for holding internal organs or pushing them aside. A net 65 has a plurality of holding points 652, each can be attached to an anchoring point created using either of the structures detailed above

Fig. 15 details means for holding an internal organ by attaching it to a virtual anchor point 572 , and connected through a wire 24 to vacuum cup/grasper means 51 to attach to an internal organ.

Several organs can thus be secured to one anchor point, using several wires 24 , each with its grasping means 25 attached thereto.

In laparoscopic procedures, the attachment means may be fixed to the undersurface of the cavity and moved from one position to another using endoscopic instruments such as graspers under the direct vision the endoscope.

Fig. 16 details an inflatable balloon 66 with affixed virtual port devices, being secured to two cavity or abdominal walls 11, 14.
The inflatable balloon 66 may include holding means 67, 68 to attach to above walls - such as asperities on the extremities of the balloon 66, vacuum cups or any of the above means.

Furthermore, the balloon 66 may include inflating means 69 , such as a tube to inflate with a fluid. When inflated, the balloon 66 may be used as a support means inside the body, or a means to move internal organs therein.

Fig. 17 details vacuum cup with a two-state valve in its Closed state. The vacuum cup 51 has a flexible valve tube 591 which is closed, and a rigid valve tube 592 partially inserted therein.

Fig. 18 details vacuum cup with a two-state valve in its Open state. Method of operation: the valve is normally in its Closed state, due to elastic action of rubber tube 591.
To create vacuum, connect to vacuum pump and press rigid tube 592 into cup, through rubber tube 591. Air is eliminated and vacuum created. The elastic surface of cup 51 is drawn in by the vacuum, keeping the valve Open.

When vacuum inside cup 51 disappears, for example when the side of the cup 51 is lifted up, then there is no longer vacuum to hold the valve Open, and it automatically reverts to its Close state. In this state, the cup 51 is disconnected from the vacuum pump 7. Vacuum is still supplied to the other cups in the system, cups which are connected to the same pump 7 through the common vacuum tube 52. Vacuum will not escape through the disabled cup, since the valve there has reverted to the Close state.

Fig. 19 illustrates a plurality of vacuum cups 51 connected to a common vacuum pump 7.
The vacuum cups 51 may be attached to cavity or abdominal walls 11, 14 and, through vacuum tubes 52, to a vacuum pump 7.

A wire 24 can be pulled to exert a force as desired by the surgeon, and held in place with ratchet mechanism 23.

Fig. 20 details vacuum cup with a two-state, toggle-switch activated valve in the Vacuum Activate state.

This is another solution to the problem of independent control over several cups which are connected to a common vacuum pump.

Problem - when disconnected from body, to keep vacuum in tubes, as same tube is connected to several cups. One cup can be disconnected, whilst the rest of them still operate under vacuum.

Method of use:
1. connect cup to vacuum pump using a tube.
2. open valve by pushing the Open pushbutton on the device
3. to disconnect, press Close pushbutton then lift side lip of cup to allow air to enter .
4. If left closed - can disconnect from pump, retains vacuum.

The vacuum cup 51 is attached to cavity or abdominal wall 11 and, through vacuum tube 52, to a vacuum pump 7.
The valve 81 is illustrated with Vacuum Activate button 82 in depressed state. The air passage 84 is then open from cup 51 to pump 7, whereas the Close Cup button 83 is inactive.

Fig. 21 details vacuum cup with a two-state valve in the Vacuum Preserve state. In this state, the Close Cup button 83 is in depressed state, and the Vacuum Activate button 82 is inactive. In this state, the air passage 84 is blocked, preventing air flow between cup 51 and pump 7 through the vacuum tube 52.

In this state, the valve 81 is closed, and preserves the vacuum in cup 51 even if the pump 7 is deactivated or disconnected.

If cup 51 is disconnected, and there is no more vacuum therein, this will not affect the performance of pump 7, which may supply vacuum to other cups which may be connected to the same tube 52.
Air will not penetrate the tube 52, since the valve 81 is closed.

Fig. 22 details vacuum cup with a three-state, switch-activated valve in the Vacuum Activate state.

The three states include:
1. Vacuum Activate, to connect cup to vacuum pump to generate vacuum in the pump to attach it to an internal body organ;
2. Vacuum Preserve, valve closed and vacuum preserved in the cup;
3. Vacuum Release, opening a path for air or fluid to enter the cup from the surroundings.

Problem - when disconnected from body, to keep vacuum in tubes, as same tube is connected to several cups. One cup can be disconnected, whilst the rest of them still operate under vacuum.
Also - to release the cup without applying force thereon.

Solution: a control lever 85 is rotated into a position so as to orient the air passage 84 towards the vacuum tube 52, connecting it to the pump 7.
In this state, the valve is open, allowing the pump 7 to create vacuum in the cup 51.

Fig. 23 details vacuum cup with a three-state, switch activated valve in the Vacuum Preserve state.
The control lever 85 is rotated into a position so as to orient the air passage 84 towards a wall or block in the device.
The valve 81 is blocked, preventing air flow between cup 51 and vacuum pump or the ambient.
In this state, the valve 81 is closed, and preserves the vacuum in cup 51 even if the pump 7 is deactivated or disconnected.

The outlet 86 to the vacuum pump is blocked, so as not to disturb the vacuum to other cups, even if there is no more vacuum in cup 51.

Fig. 24 details vacuum cup with a three-state, switch activated valve in the Vacuum Release state.
The control lever 85 is rotated into a position so as to orient the air passage 84 towards an outlet 87 which is open to the ambient air, or air in the abdominal cavity.

Air from the ambient enters the cup 51 and cancels the vacuum therein.
The outlet 86 to the vacuum pump remains blocked, so as not to disturb the vacuum to other cups, even if there is no more vacuum in cup 51.

Fig. 25 illustrates an electronically-controlled vacuum pump 7.
Problem - to generate vacuum for a predefined time period, then to stop it so as not to damage internal body organs.
Solution: A timer 71, activates pump for a predefined time interval when receiving a trigger input 711, for example pushing a button there.

The optional time interval setting input 712 may be used to set that interval.
When the time interval is about to end, or a predefined time before that, an indicator 713 indicates to the surgeon that the vacuum is about to end. The indicator 713 may include a light or a buzzer or a combination thereof, for example.
A pump controller 72 controls the vacuum level as desired, optionally according to a vacuum control input 721 settings. The vacuum pump 73 itself generates the desired vacuum, for the time period as desired, at outlet 731. A battery 74 generates the electrical power for the device.

Fig. 26 illustrates a cup-moving means with partial vacuum reduction, using a metallic ball 91 with an obstruction 92, which is rotated by means of coils 93, for generating a rotating magnetic field, to rotate the ball 91.

As the ball 91 is rotated according to external commands from the surgeon, the cup 51 is pulled sideways in the desired direction.
A partial reduction in the vacuum level may facilitate the movement of the cup 51, which remains attached to the abdominal wall 11.

Fig. 27 illustrates another cup-moving means with partial vacuum reduction, including a metallic ball 91 with asperities/teeth 94 on its outer surface, which allows to move the cup 51 as the ball is rotated on the tissue 11 the cup 51 is attached to.

Various embodiments of the present invention may be implemented. For example, in Figs. 17 and 18, the valve may further include means for releasing the vacuum in the cup 51 whenever the surgeon finds this necessary, using laparoscopic tools.

Laparoscopic tools allow to push and pinch various means in the cup 51. Accordingly, release means are installed on the cup 51 or the tube 592 or the tube 52, allowing to open the cup to the ambient. The release means may be implemented for example using a flexible part 593 normally covering an opening there.

In the normal or rest state, there is overlap between two parts, such that ambient air or fluid cannot penetrate into the cup 51.

When pressed and/or deformed by the surgeon, part 593 allows air or ambient fluid to enter the cup 51, to cancel the vacuum within the cup. This releases the cup 51 and detaches it from the surface it has been attached to by means of the vacuum therein.

In Figs. 17 and 18, the valve may have a structure including means for performing as follows:

a. Vacuum is formed in the cup 51 by air suction through tube 592;
b. whilst there is vacuum in the cup 51, the valve holds itself open by a deformation in its outer shape, thus
keeping the rigid tube 592 within the flexible tube 591;
c. when there is no longer vacuum within the cup 51, the valve automatically shuts itself, for example by the cup returning to its normal rest shape and/or releasing the rigid tube 592 out of the flexible tube 591;
d. vacuum release means, implemented for example using a flexible part 593 which when pressed, allows air or ambient fluid to enter the cup 51, to cancel the vacuum within the cup. This releases the cup 51 and detaches it from the surface it has been attached to by means of the vacuum therein.

The above description details the use of one cup as a virtual port, or support for holding internal organs during an operation. When the surgeon desires to apply a larger force, or to hold larger organs, it is possible to use several cups. This also helps to share the force among several locations within the body, or over a larger area.
In this embodiment, several cups are attached to an internal wall of the body, for example the abdominal cavity. Each cup may be attached using vacuum and/or magnetic force. The cups may be connected together using wires or a solid plate. The plate may be either rigid or flexible, as the need be. The cups thus connected are then used to support the weight as desired or to apply the required force.

It will be recognized that the foregoing is but one example of an apparatus and method within the scope of the present invention and that various modifications will occur to those skilled in the art upon reading the disclosure set forth hereinbefore.

Claims

1. An anchoring device for surgery, comprising first attaching means for attaching the device to an internal surface within the human body and second attaching means for attaching to surgical instruments or devices.

2. The anchoring device according to claim 1, wherein the first attaching means use vacuum to attach to the internal surface within the human body.

3. The anchoring device according to claim 1, wherein the first attaching means use magnetic fields to attach to the internal surface within the human body, and using a magnet or electromagnet on the exterior surface of the cavity, outside of the human body.

4. The anchoring device according to claim 1, wherein the first attaching means use mechanical means such as barbs, fixation wires or a self retaining clamp.

5. The anchoring device according to claim 1, wherein the first attaching means use an inflatable balloon with affixed virtual port devices being secured to two cavity or abdominal walls, and including holding means for attaching to the two cavity or abdominal wall.

6. The anchoring device according to claim 1, wherein the first attaching means use an adhesive attachment means such as a pressure adhesive gel.

7. The anchoring device according to claim 1, wherein the first attaching means include means for attaching to the internal surface of a cavity or to various organs within a cavity, during minimally invasive surgery.

8. The anchoring device according to claim 1, wherein the surgical devices attached to the second attaching means include wires for attaching to another internal surface of a cavity or to various organs within a cavity, to generate a pulling force during minimally invasive surgery.

9. The anchoring device according to claim 1, wherein the surgical devices attached to the second attaching means include rods for attaching to another internal surface of a cavity or to various organs within a cavity, to generate a push away force during minimally invasive surgery.

10. The anchoring device according to claim 1, further including means allowing it to be moved from one position to another and to be reattached to the undersurface of the abdominal wall, or to various tissues within a cavity, without creating any additional openings in the cavity wall.

11. The anchoring device according to claim 1, further including means for attaching a plurality of anchoring devices together for holding a larger weight or for distributing the load therebetween.

12. The anchoring device according to claim 1, further including ratchet means for holding a string to apply a force as desired, or for releasing the string to stop applying the force when it is no longer required.

13. The anchoring device according to claim 12, wherein the ratchet means include a self locking ratchet mechanism with means for manual or remote release of the string tension, or using other mechanisms such as springs.

14. A vacuum cup for anchoring surgery devices during surgery, comprising means for creating a vacuum inside the cup, and attaching means for attaching to surgical instruments or devices.

15. The vacuum cup according to claim 14, further including vacuum release means for allowing ambient fluid into the cup, when activated by a surgeon.

16. The vacuum cup according to claim 15, wherein the vacuum release means includes means for its activation using laparoscopic means.

17. The vacuum cup according to claim 15, wherein the vacuum release means includes flexible means which, when pressed or deformed, allows ambient fluid into the cup to cancel the vacuum there, when activated by a surgeon.

18. The vacuum cup according to claim 14, wherein vacuum is applied through a valve connected to vacuum generating means, and wherein the valve further includes means for holding it open by keeping a free passage for fluids whilst there is vacuum in the cup, and for automatically shutting itself by closing the fluids passage when there is no longer vacuum in the cup.

19. The vacuum cup according to claim 14, further including means for attaching a plurality of cups together for holding a larger weight or for distributing the load therebetween.

20. An electronically-controlled vacuum pump comprising vacuum pump means, timer means for activating the vacuum pump for a predefined time interval when receiving a trigger input, and indicator means for indicating to a surgeon that the vacuum is about to end.

21. The electronically-controlled vacuum pump according to claim 20, wherein the indicator means include a light or a buzzer or a combination thereof.

22. The electronically-controlled vacuum pump according to claim 20, further including a pump controller for controlling the degree of vacuum level as desired.

23. An anchoring device for surgery, comprising first attaching means for attaching the device to an internal surface within the human body and second attaching means for attaching to surgical instruments or devices, wherein the first attaching means comprise a wire piercing the abdominal wall for fixation thereto.

24. An anchoring method for surgery, comprising:

A. attaching pulling means to the abdominal wall;

B. pulling the abdominal wall upwards, to lift the abdominal wall during atmospheric pressure (gassless) laparoscopy.

25. The anchoring method according to claim 24, wherein attaching pulling means to the abdominal wall using magnetic attraction.

26. The anchoring method according to claim 24, wherein attaching pulling means to the abdominal wall using wires piercing the entire thickness of the cavity.

27. The anchoring method according to claim 24, wherein performing an initial port using positive pressure laparoscopy, then attaching the attachment means to the undersurface of the cavity, to be subsequently used for endoscopic retraction and for retraction of the body wall, thus serving a dual role.

28. The anchoring method according to claim 24, wherein attaching the devices on the outer surface of the cavity to a frame or to rods fixed to the operating table, to the operating room floor or ceiling and serve for lifting the cavity wall, thus permitting to perform a surgical intervention without the necessity to insufflate the cavity with gas.

Abstract

A device auxiliary to surgery, for anchoring and lifting cavity walls or internal organs of a patient. The device provides a virtual port, that is an instrument that can be non-invasively, or minimally invasively and removably attached to the undersurface of a patient's cavity, or to various tissues within a cavity, and to which various retracting means are attached. The device includes means allowing it to be moved from one position to another and reattached to the undersurface of the abdominal wall, or to various tissues within a cavity, without creating any additional openings in the cavity wall. The device includes means for attaching various retractors.

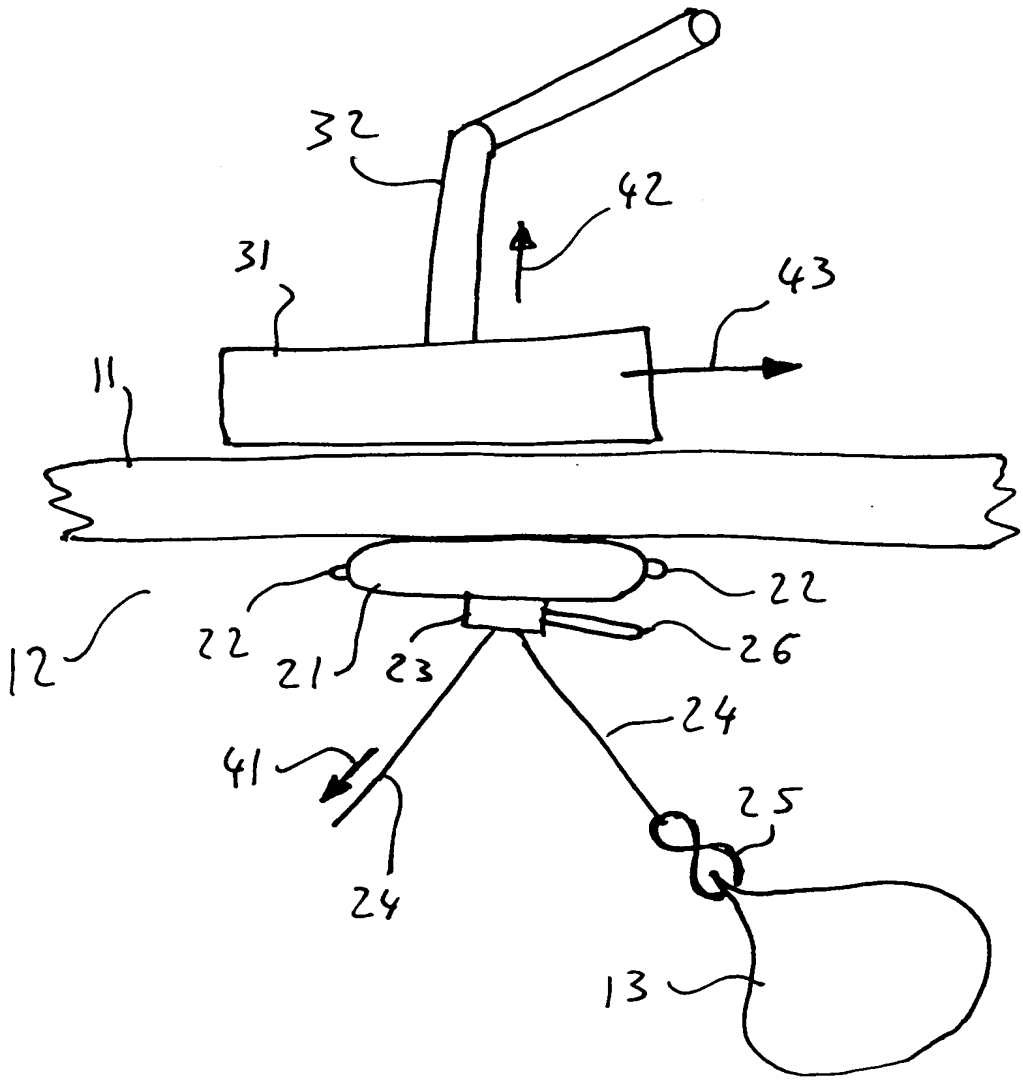

Fig. 1

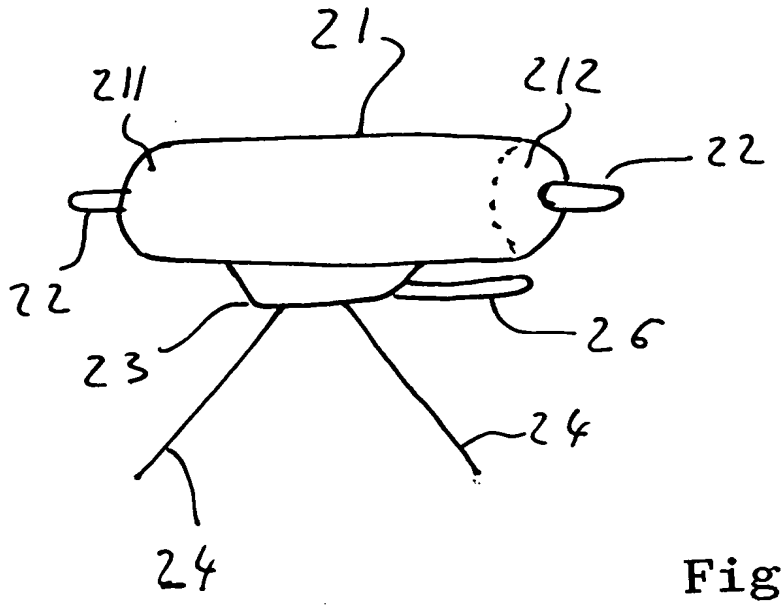

Fig. 2

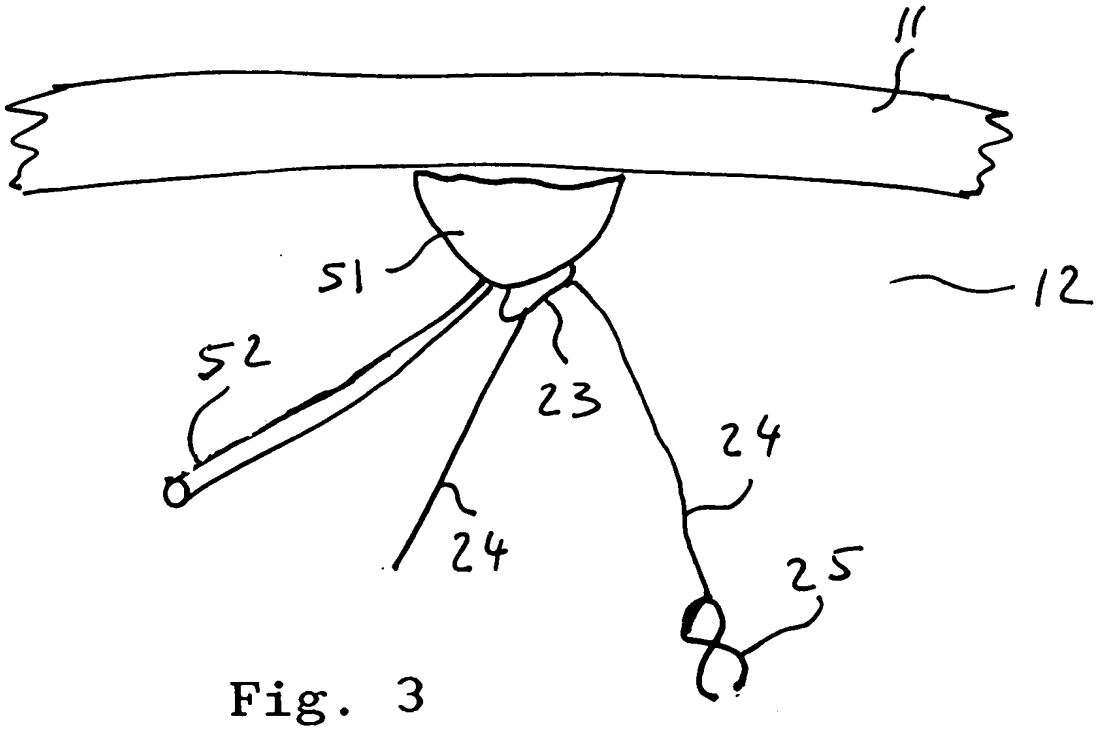

Fig. 3

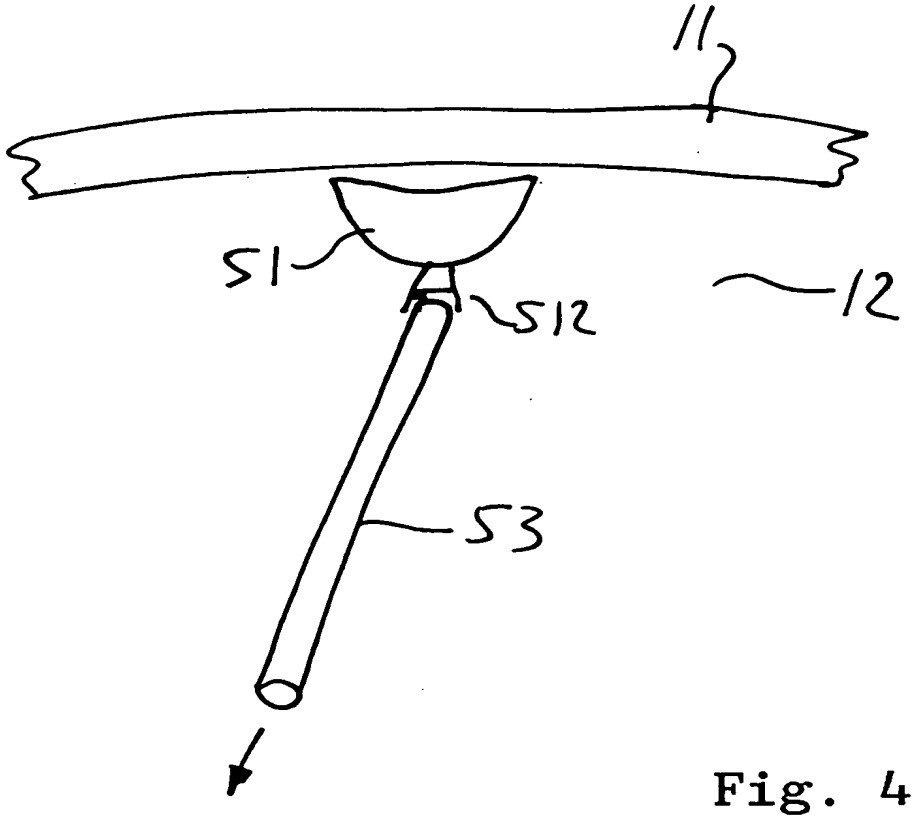

Fig. 4

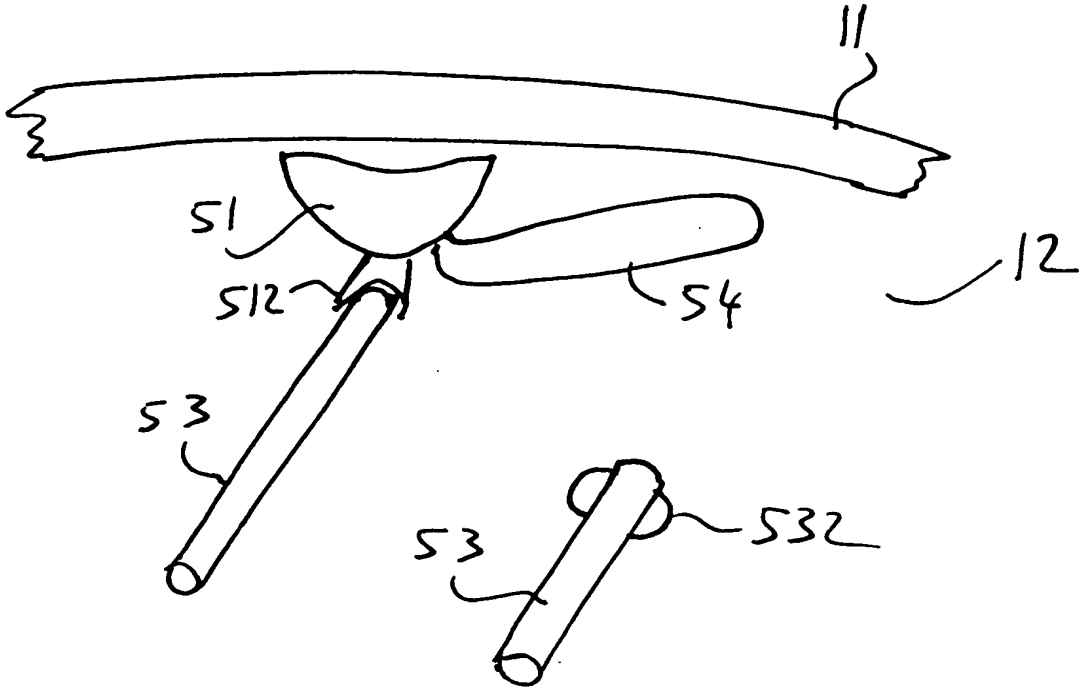

Fig. 5

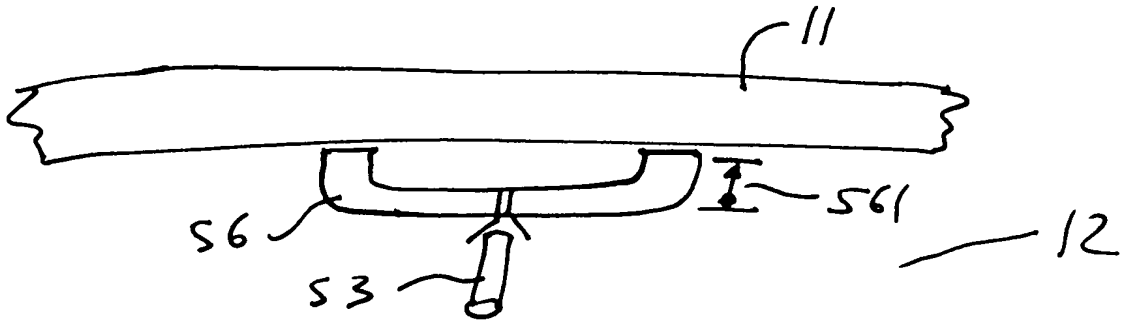

Fig. 6

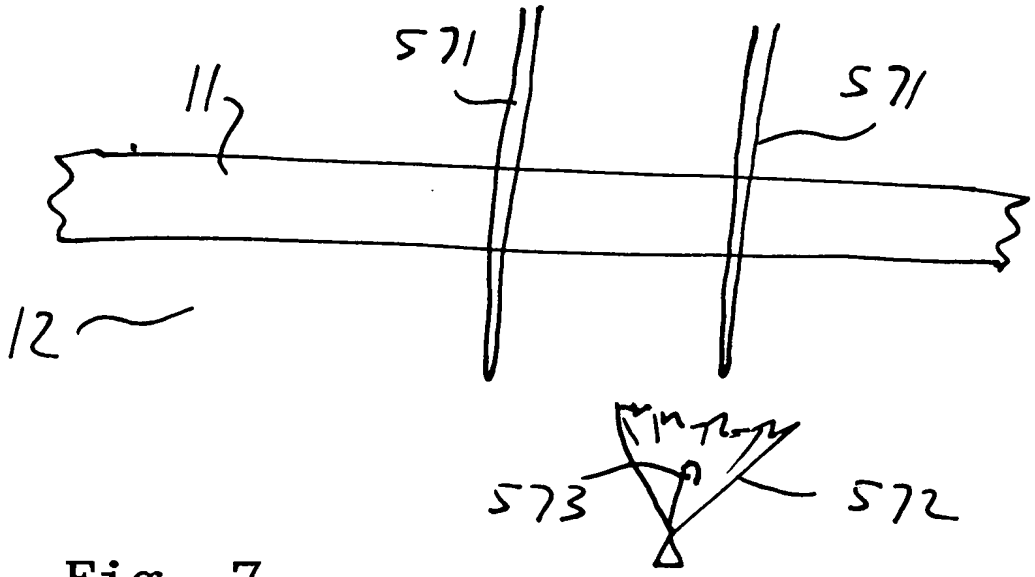

Fig. 7

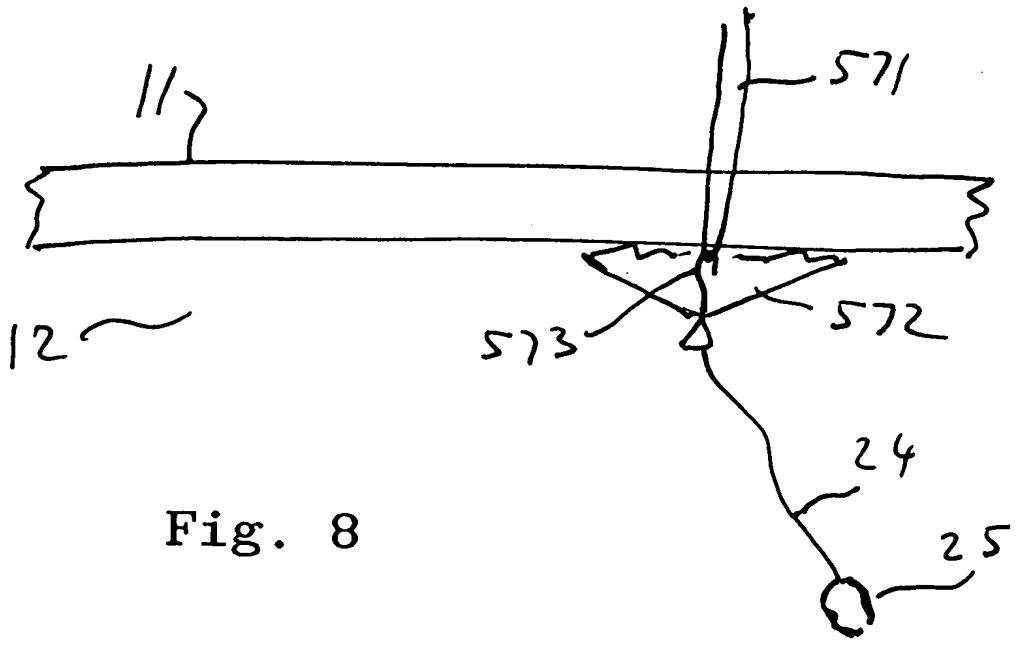

Fig. 8

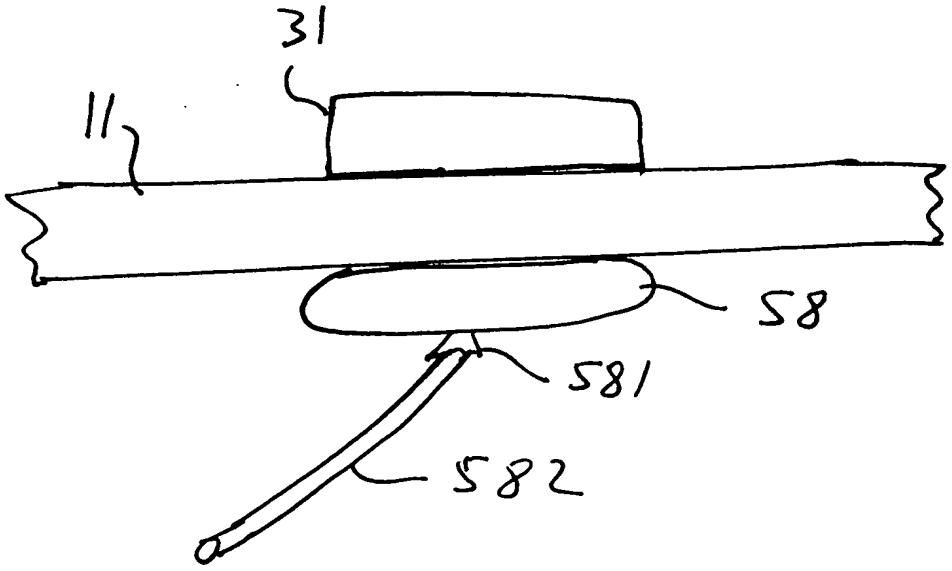

Fig. 9

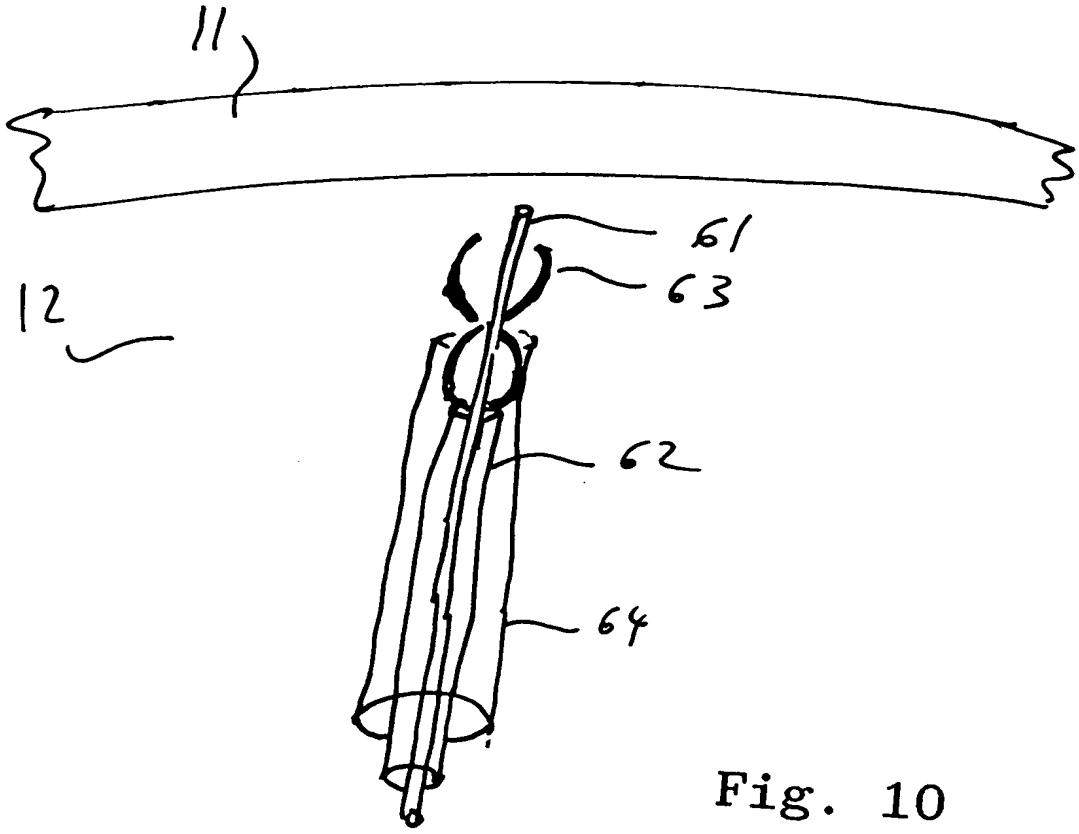

Fig. 10

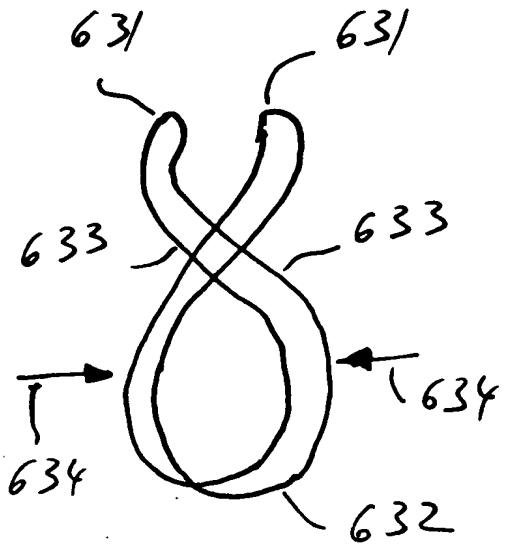

Fig. 11

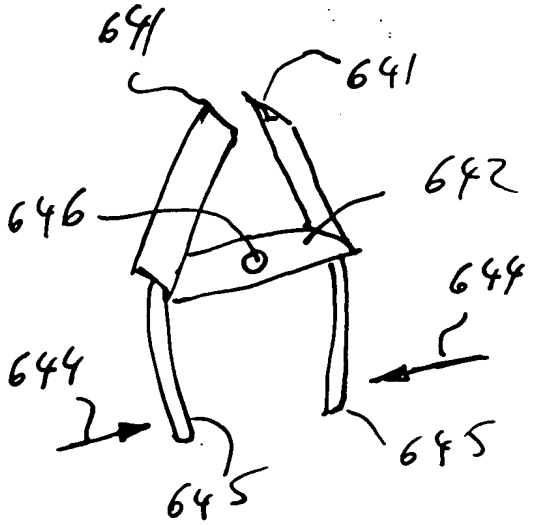

Fig. 12

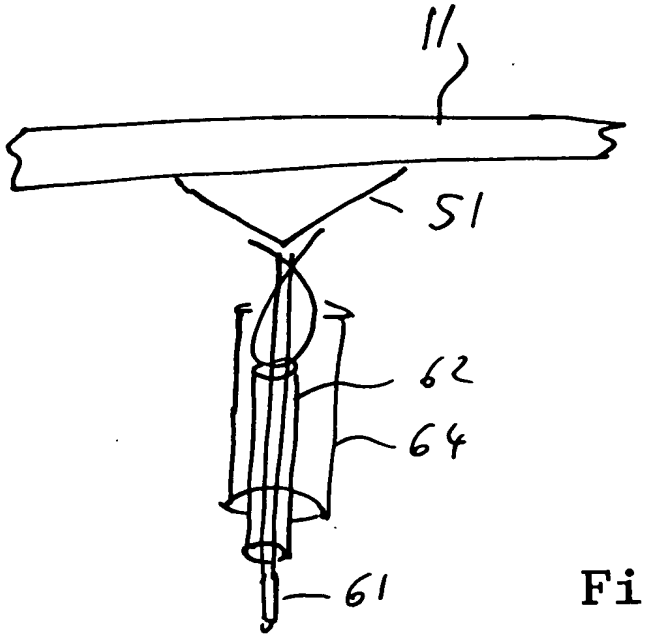

Fig. 13

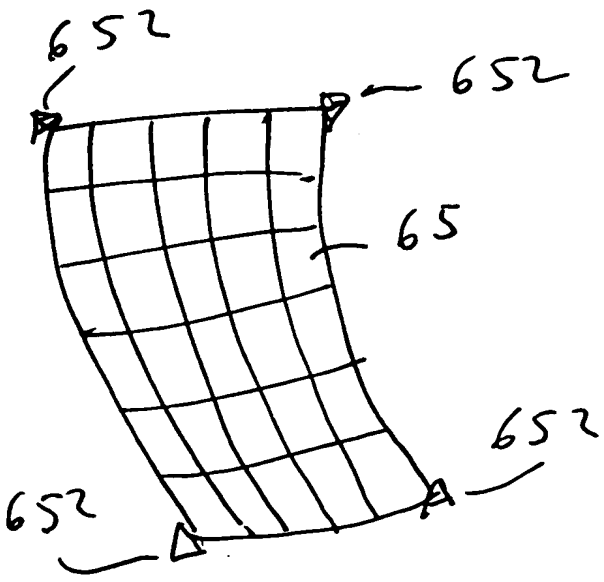

Fig. 14

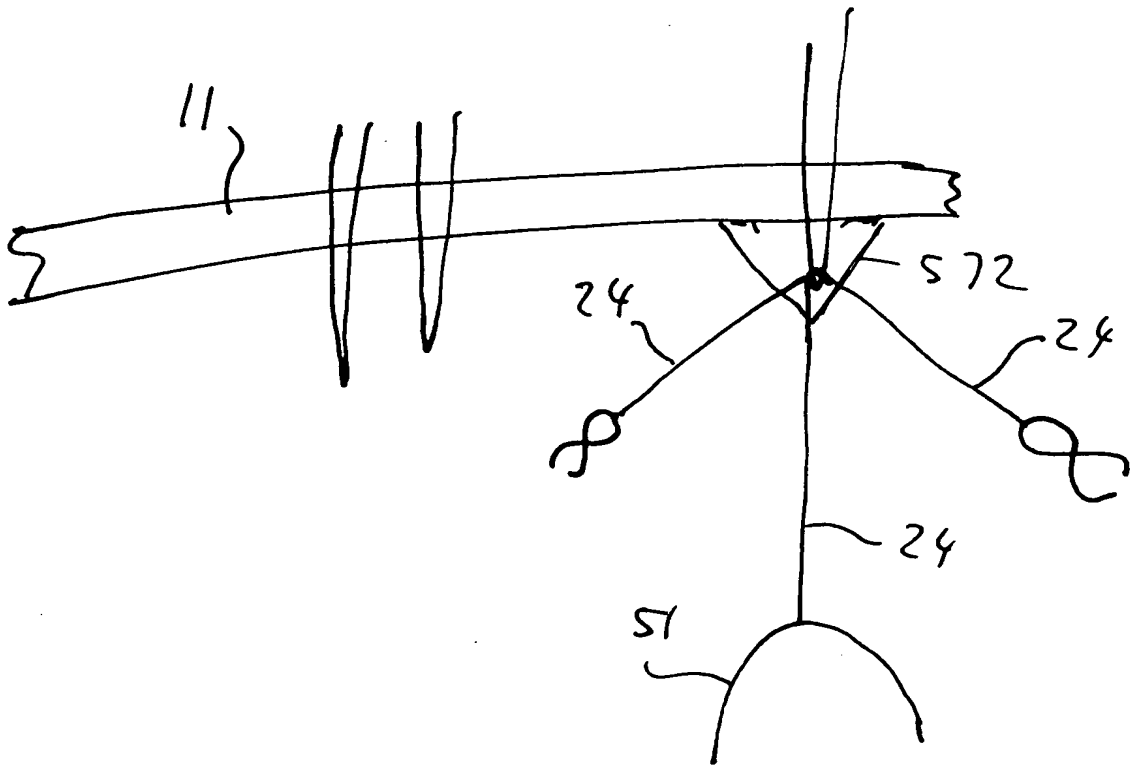

Fig. 15

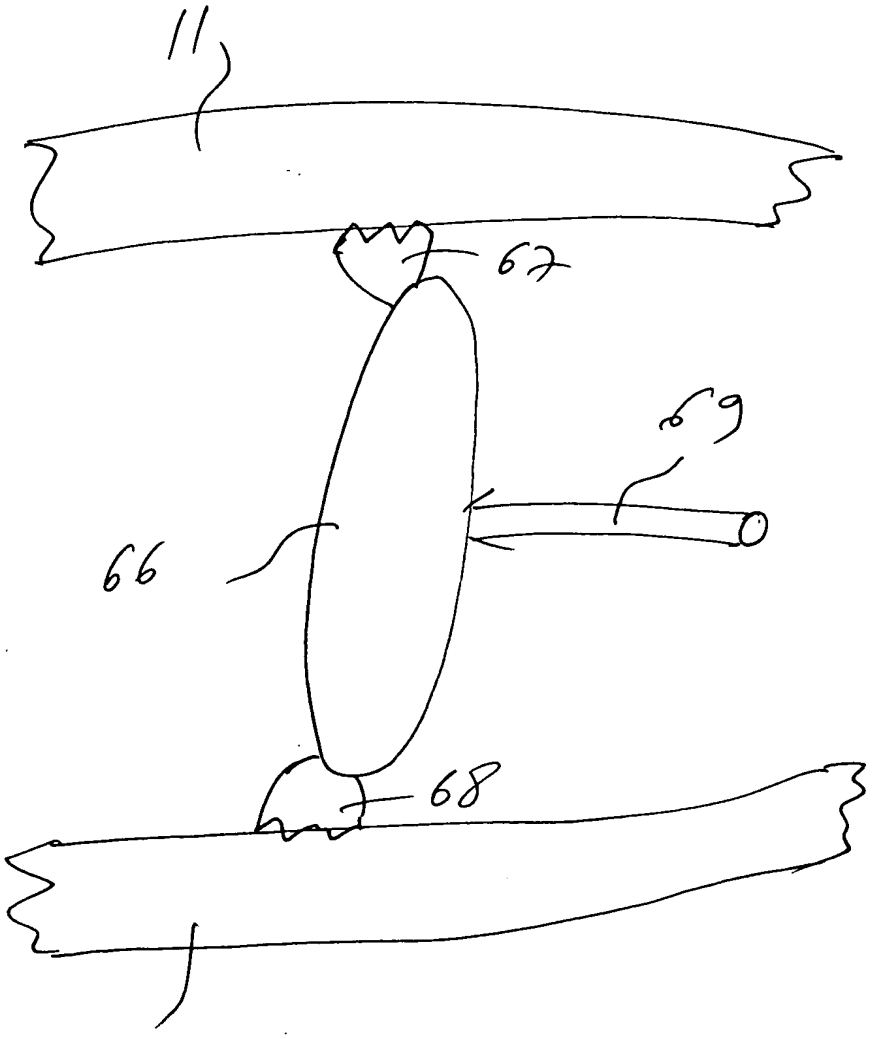

Fig. 16

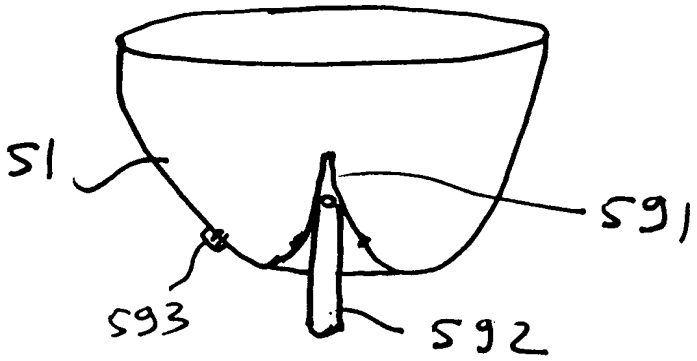

Fig. 17

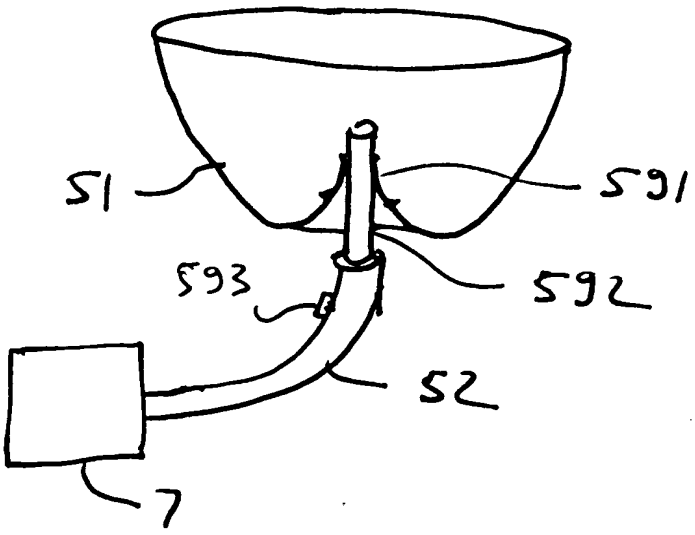

Fig. 18

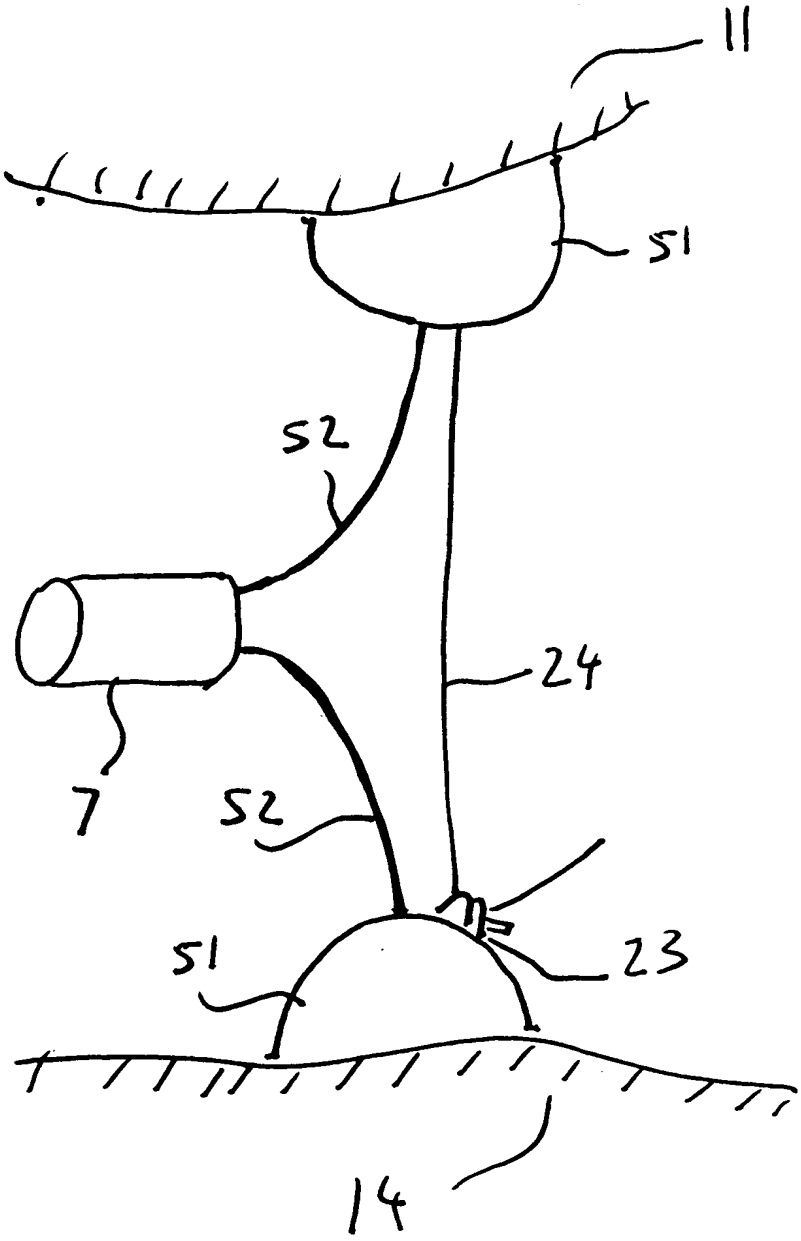

Fig. 19

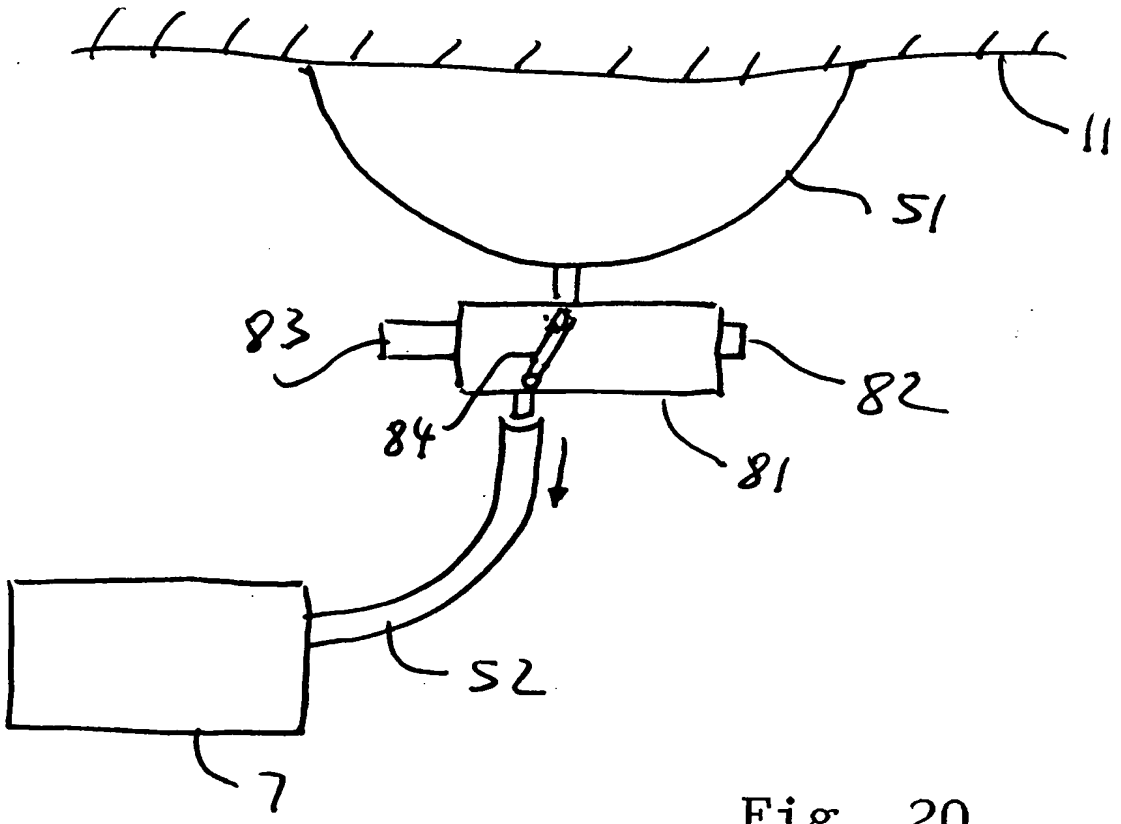

Fig. 20

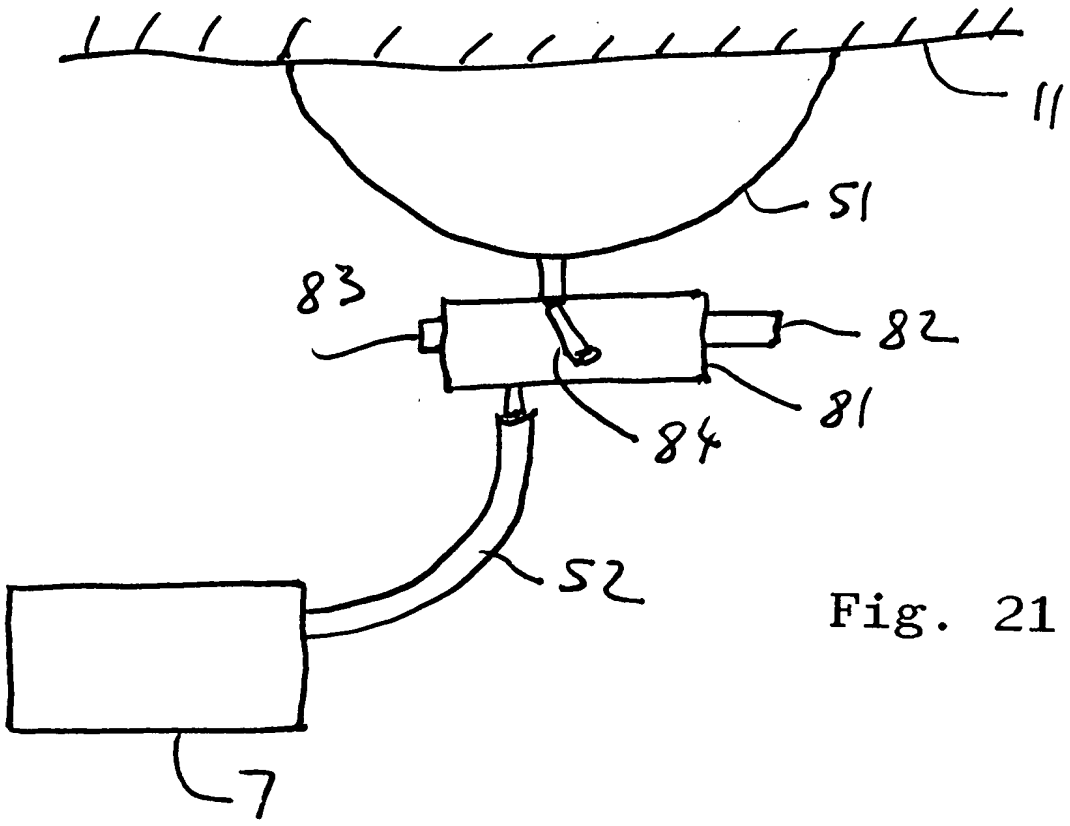

Fig. 21

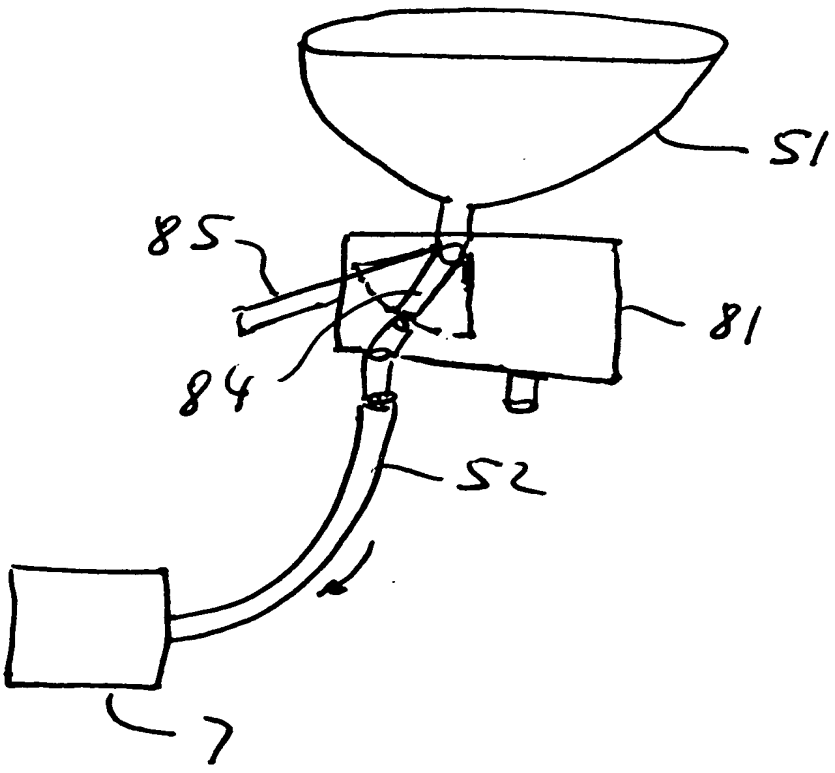

Fig. 22

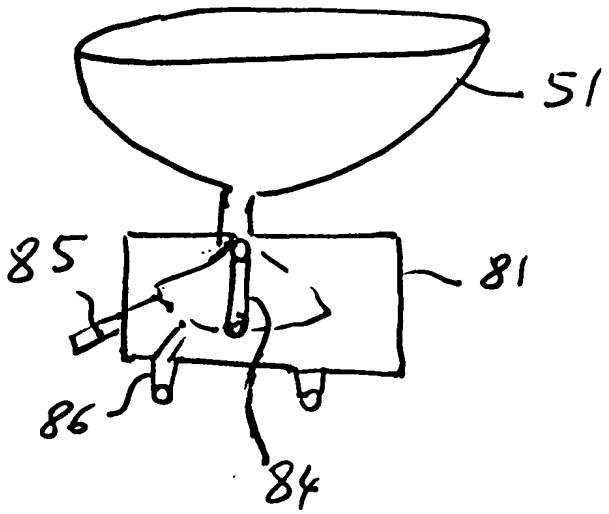

Fig. 23

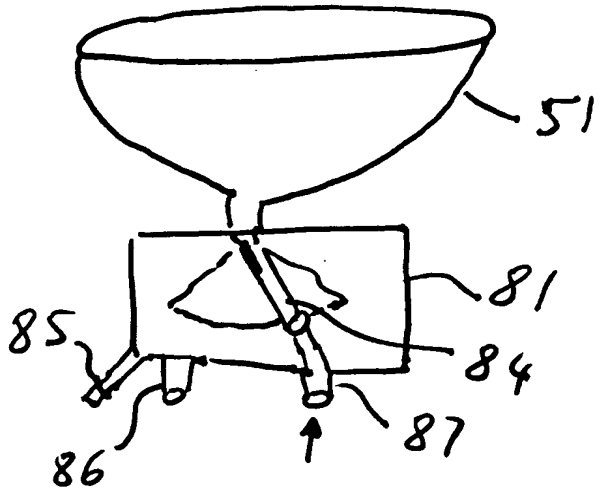

Fig. 24

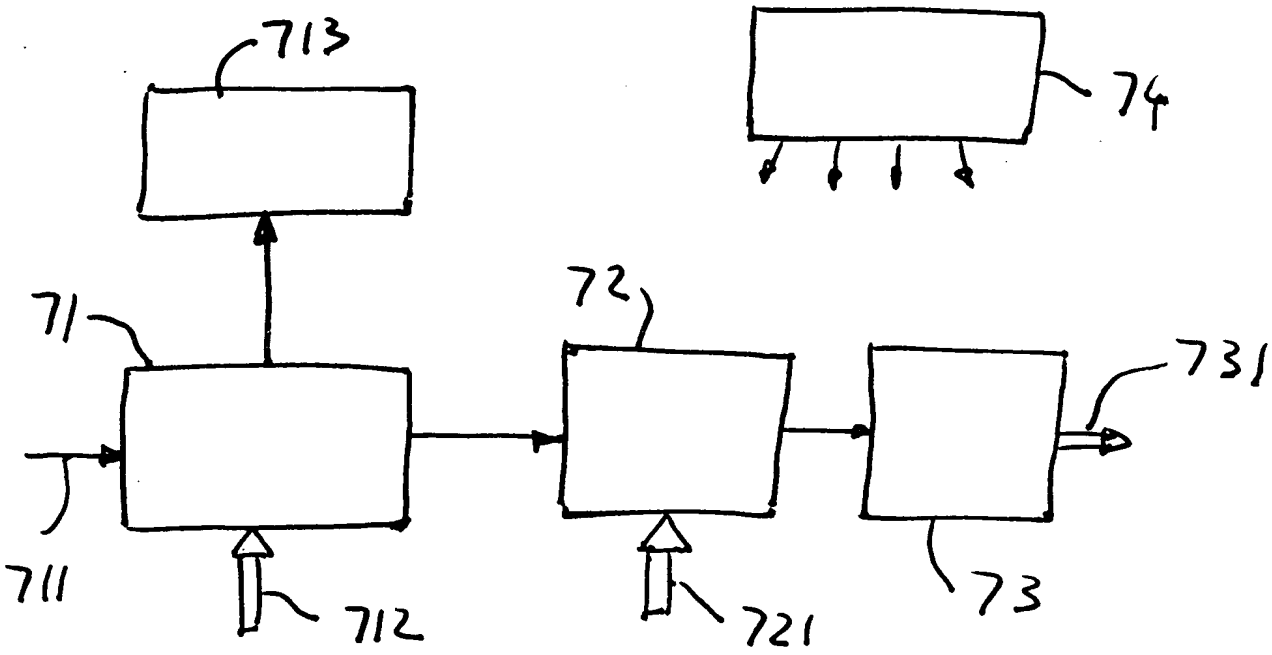

Fig. 25

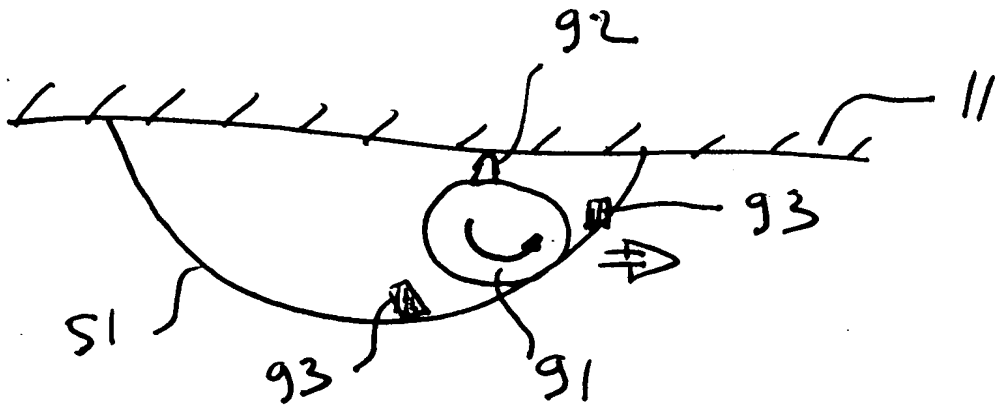

Fig. 26

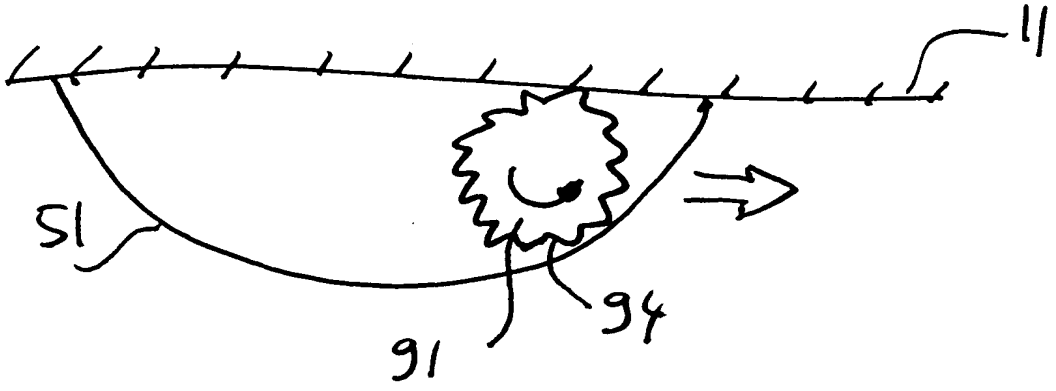

Fig. 27